

Familiar Ferns in a Far Flung Paradise

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In the summer of 2011 I was lucky enough to spend 3 months at Laguna Blanca Nature Reserve in Paraguay, South America. Para La Tierra, a not-for-profit conservation organisation, runs a small research station there and took me on as a Botanical research intern for the summer. Paraguay is a land locked country in the heart of South America practically untouched by tourism; however agriculture, cattle farming and urban development are an ever present threat to its vast array of ecosystems and habitats.

Nestled in the heart of rural Paraguay, where the locals speak native Guarani, and the nearest form of civilisation is a small village 45 minutes away down dusty red tracks, is a true paradise; a beautiful clear blue lake and bright white beach, surrounded by astounding flora and fauna just waiting to be recorded and studied. (Fig. 1)



Fig.1 The beautiful view of sunrise over the lake which I woke up to most mornings.

Land bordering the reserve has been stripped and burned to create either arable farmland planted with crops such as maize and soya, or pastoral fields filled with grazing cattle or horses. Despite being just a small fragment of natural vegetation only covering around 8km², Laguna Blanca is thus a very important site where native communities cling on amidst a sea of agriculture. Moreover within this small area four major habitats coalesce to form a unique mosaic of cerrado, dry forest, Atlantic forest, and riparian zones comprised of a large 1.47km² artisan lake, and small river.

With no mountain chains in the area the entire reserve is very flat at around 150m above sea level, resulting in winds exceeding 22km/h for 14% of the year, furthermore any sudden switches between northerly and southerly winds brings about abrupt shifts in weather, ranging from hot dry air to tropical storms, frosts and even hailstorms. Sitting just below the Tropic of Capricorn, between 23°50 and 23°46S and 56°16 and 56°18W, it is not uncommon for yearly temperatures to reach lows of -5°C in winter, to highs of over 40°C in summer, while the average annual rainfall is around 1250mm (Hacker, et al. 1996: Gauto, et al., 2011: Glatzle and Stosiek, 2006).

After two weeks exploring each habitat within the reserve I had to design my own research project from scratch. Having never travelled in South America before my botanical knowledge of the area was poor; many

of the trees, shrubs and herbs appeared very alien. However the abundance and diversity of enchanting ferns caught my attention straight away, proving relatively familiar in such foreign surroundings. Hence I developed a study which looked at the impacts of environmental factors upon the fern species distribution throughout the reserve.

Three large 1 hectare plots were set up in each habitat type, within which ten 10x10m quadrats were sampled, thus 120 quadrats were surveyed in total. The vegetation of each quadrat was assessed using the DOMIN scale of % vegetation cover, while the primary environmental factors tested for were; soil pH, % soil moisture, % light reaching ground level, soil conductivity and soil salinity. However due to the delayed arrival of the required probes some of the data collection is ongoing, therefore I cannot give you a full account of my results in this article. Nevertheless I can show you some of the amazing ferns that I discovered. With no flora guide specifically for Paraguay, let alone one for its fern species I had to use various keys from neighbouring countries (which were often in Spanish), online databases and local expertise to determine what species I was dealing with.

Covering around 60% of the reserve the cerrado (see Fig. 2) forms the largest habitat area. Patches of extensive grassland, hardy shrubs, and scrubby trees intermingled with large termite mounds, form a savannah type landscape with many of the plants adapted to cope with fire. Large underground root systems allow rapid



Fig.2 Typical cerrado landscape and vegetation

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uptake of water when it rains, while fleshy tubers store water and allow some plants to retreat below ground, while many tree species have thick corky bark to protect vital transportation tissues within. Exposed sandy soils with low organic matter content bear the scars of previous fire events, whereby patches of blackened ground are left bare. Thus, without any such capability to withstand such intense fire pressures, lack of moisture and organic material, the cerrado yielded no fern species.

The dry forest, more specifically known as 'semi deciduous mesophytic transitional forest', forms a small elongated habitat totalling around 1km² adjacent to the cerrado (Eiten, 1972). Generally the canopy height is around 20m of moderate density, and the understory is often quite patchy, made up from low rambling vines (Fig. 3), and succulents. Where the understory opened out and was not completely dominated by vines or succulents, a few specimens of *Pecluma ptilodon* were found. The fronds stood erect amidst very dry leaf litter, and showed signs of heavy herbivory and damage, demonstrated in Fig. 4.

In comparison some other *P. ptilodon* plants were found on the margins of the lake and were in much better condition, nevertheless all plants were producing a good amount of fertile fronds. Two epiphytic species were also found in the dry forest, *Microgramma vacciniifolia* and *Pleopeltis pleopeltifolia*. The former has rhizomes that look much like a vine wrapped around the tree trunk and often runs from the forest floor to the upper canopy; furthermore it has highly dimorphic sterile and fertile fronds as shown in Fig. 5. *P. pleopeltifolia* in comparison has a very small anchorage network of rhizomes and roots while its finger like fronds grope outwards from the



Fig.3 The low network of vines that create patches of dense understory in the dry forest, only where these patches broke up were ferns found.



Fig.4 Damaged fronds of *Pecluma ptilodon* in the dry forest.



Fig.5 *Microgramma vacciniifolia* entwined around the trunk of a tree showing both the round sterile fronds, and the fertile much more elongate fronds as well.



Fig.6 Open area where *Adiantum pectinatum* thrived, however the specimen in the foreground shows some yellowish discoloration.

trunks. However these two species only occurred in very small numbers along the outer edge of the dry forest nearest to the lake, where the heavy mists and morning dew penetrated through. Again both species were much more healthy and abundant within the riparian zones.

A relatively small fragment of Atlantic forest totalling around 2km² extends out southwards from the reserve. Here the forest canopy is higher and much denser than the dry forest with a well developed understory. Unfortunately I could only explore the forest from the ground thus some species that may have been found in the high canopy were probably missed, nevertheless I found a total of seven fern species in this habitat.

Occurring in 60% of all the plots within the Atlantic forest, the most abundant species was *Adiantum pseudotinctum*. This species dominated the ground flora where the forest canopy opened up, thus received slightly higher light levels in comparison to other areas in the forest which experienced deep shade throughout the day. Traditionally this fern is used medicinally by the Guarani people whereby they crush it up and mix it in with 'Yerba mate' to form a strong beverage akin to tea – the taste is rather unique and not for everyone! Another *Adiantum* species found in this habitat was *Adiantum pectinatum*, a very delicate fern with almost transparent fronds. Again this species was only found in more open areas of the forest with enhanced light levels and, in such areas, it occurred in abundance as in Fig. 6. However often the specimens had discoloured yellowish brown



Fig.7 Healthy looking frond of *Pteris denticulata* showing how the fronds grow very close to the ground.

pinnae and I could find very few fertile fronds. *Pteris denticulata* proved to be the most widespread species cropping up in over 70% of all the Atlantic forest plots; however it was always found in much lower densities than *A. pseudotinctum*. The dark green foliage was often sprawling amidst other vegetation leaving the fronds themselves on, or close to, the ground making it difficult to spot shown in Fig. 7. Furthermore many fronds were damaged presumably caused by herbivore activity, and relatively few fertile fronds were found throughout the 3 month study.

Two rather more interesting species found in the Atlantic forest plots were *Thelypteris abrupta* and *Dennstaedtia globulifera* (Fig. 8). The latter species has a growth form similar to bracken with tall large fronds that form a dense canopy and, within a localized area, dominated the ground flora; however it was not well distributed throughout the forest occurring in just 16% of the plots. *T. abrupta* was reasonably widespread found in just over 43% of the plots, generally it was always located within deep shade where the soil was



Fig.8 Typical sori of *Dennstaedtia globulifera* set in 'cup' like structures.



Fig.9 The asexual reproduction method employed by *Thelypteris abrupta*.

damp to touch and the foliage glistened with moisture. Furthermore many of the fronds demonstrated their ability to reproduce asexually whereby small buds are formed on the tips of the mature fronds, and then, when they are big enough, they drop off to form an entire new plant. (Fig. 9)

One of my favourite species within the Atlantic forest was *Lastreopsis effusa* (Fig. 10) due to the big luxuriant



Fig.10 My herbarium press of *Lastreopsis effusa* showing its delicate structure and bright circular sori.

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clumps it formed, radiating sunlight wherever it fell on the slightly shiny adaxial surface of the fronds. This was not a common species, only found in 13% of the Atlantic forest plots; those in which it was found had dense canopy cover and a well developed understory creating permanent deep shade conditions. Another species that popped up in just 10% of the plots on very damp dead wood nestled in amongst spongy moss was *Doryopteris concolor*. This delicate little palmate fern has a black stipe and rachis with very small fronds around 8cm across at the largest, thus every inch of the plots had to be thoroughly searched so that no specimens were missed. My muddy knees and elbows efficiently demonstrated my fern dedication by this point!

The final areas surveyed for ferns included the large artisan lake and small accompanying river (Fig. 11) which actually flows out of, rather than into, the lake. This is due to the fact that the lake is ground water fed from the extensive water store within the Guarani Aquifer System which extends underneath 4 countries; Argentina, Brazil, Paraguay and Uruguay (Wendland, et al., 2007). Extensive reed beds flank the lake shore, interspersed with sandy beaches and swathes of gallery forest, technically classed as 'evergreen mesophytic or hydrophytic forest'. Gallery forest usually forms a narrow strip of woodland no wider than 100m alongside water bodies, and have a permanent year round water supply as the water table is very close to the surface. The canopy tends to have a rich epiphytic flora due to rising mists and heavy morning dews, while other abundant plants include Cyperaceae, Poaceae and Juncaceae which form a dense, if somewhat low, understory (Eiten, 1972; Eiten, 1978; Redford and Fonseca, 1986). At Laguna Blanca the gallery forest extends approximately 3km along the lake shore, and flanks either side of the river for around 600m; it was this habitat that generated the highest number of fern species, 16 in total.

Some species actually had their roots and fronds partially submerged, or else on completely saturated ground, such as *Blechnum serrulatum* (Figure 12), *Lindsaea portoricensis* (Figure 13) and *Doryopteris nobilis*. The latter has impressive pale palmate fronds outlined with black venation and was very rare on the reserve, found in only one 10x10m plot although within this there were several individuals complete with fertile fronds. In contrast the other two species were very abundant found in over 30% of all the riparian plots. *L. portoricensis* is a relatively small fern and often grew intermingled with the surrounding vegetation; however it never failed to catch the eye due to its vibrant bright green fronds that waved at you in the breeze. Similarly *B. serrulatum* also has rather verdant, but singular fronds that stand robust and stiffly erect, hiding opulent burnt orange linear sori underneath. Generally this species was found alongside patches of *Pityrogramma calomelanos* (Fig. 14) providing a stark contrast with the underside of the delicate fronds being a distinctive silvery-grey in colour.



Fig.11 A characteristic section of the river; other areas were often much more closed in and dense with vegetation.



Fig.12 The stiff upright fronds of *Blechnum serrulatum* and, in the top left corner you can just see the bright burnt orange linear sori.



Fig.13 A typical cluster of *Lindsaea portoricensis* fronds amongst grasses and sedges.



Fig.14 A large swathe of *Pityrogramma calomelanos* demonstrating its usual growth form.

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Vast clumps of *Thelypteris serrata* also lined the banks of the river, but were set further back in more shaded areas where its large fronds (demonstrated in Fig. 15) created dense canopy cover over the river, under which only mosses could grow. Indeed one very abundant clubmoss on the reserve was *Lycopodiella cernua* which stood like miniature Christmas trees along the lake shoreline, and is used in the same way as *A. pseudotinctum* by the Guarani people.

Where the sandy soils became drier and received stochastic inundation, *Dicranopteris flexuosa* occurred with its yellowish-green, elongate fronds protruding proud of the surrounding vegetation as shown in Fig. 16.

Adiantum serratodentatum also thrived in these conditions but was much more abundant. The latter species was sometimes found alongside *Pteridium arachnoideum* (Fig. 17) on disturbed ground that had been poached up by horses; it is Paraguay's version of bracken with the same growth form and ability to dominate the local area, often in abundance along roadsides and tracks.

Three tree fern species, *Cyathea microdonta*, *Cyathea lasiosora* and *Trichipteris atrovirens*, were scattered throughout the gallery forest and banks of the



Fig.17 The bracken like growth form of *Pteridium arachnoideum* with many brown dead fronds littering the ground.



Fig.15 One large frond belonging to *Thelypteris serrata* so named because of the serrated edges of the pinnae.



Fig.18 Two tree ferns approximately 1.5m tall on the fringe of the river.



Fig.16 The drooping fronds of *Dicranopteris flexuosa* forming a star shaped explosion of bright green foliage.



Fig.19 *Pleopeltis polypodioides* scattered all the way up and around a tree trunk.

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river, ranging from 0.5-2m tall. They proved rather tricky to key out as the scales, hairs and spikes on the stipe were some of the main features used to tell them apart. Furthermore most had extensive herbivore damage, nevertheless they created a truly majestic 'lost world' riverine environment as shown in Fig. 18.

In addition to *M. vacciniifolia* and *P. pleopeltifolia*, the gallery forest yielded a third epiphytic species, *Pleopeltis polypodioides*; a very delicate fern that protrudes horizontally outwards from small, vine like roots and rhizomes which anchor it to the trunk. (Fig. 19) When

many individuals occur they can make the tree look fuzzy and furry from a distance, and indeed when looked at more closely under a hand lens, small chestnut hairs can be seen on the adaxial and abaxial surfaces, rachis and stipe.

All in all I had a terrific time exploring the wilds of Paraguay foraging for as many ferns as I could find and I have definitely caught the bug! The data generated from this study is now the main focus of my 3rd year university dissertation project and I hope to publish the results in due course. ☐

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Another BPS?

There are plenty of organisations that use the initials BPS. A search on the internet reveals a plethora of 'British' organisations such as:-

- British Psychological Society
- British Photographic Society.
- British Pharmacological Society.
- British Printing Society.
- British Postmark Society.
- British Parachute School.

Other organisations include:-

- Boston Public Schools
- Baltimore Philatelic Society
- Buddhist Publication Society
- Birmingham Paleontological Society
- Blackheath Poetry Society

The list goes on and on. However, I was amused by the Barbados Postal Service when I saw this sign on a recent holiday. I had visions of paper aeroplanes made from envelopes flying all round the island! (AEG)

